instruction manual

Sorensen

SORENSEN
A Unit of Raytheon
Richards Avenue, South Norwalk, Connecticut

INSTRUCTION MANUAL

SERIES 1000
HIGH VOLTAGE
DC POWER SUPPLIES

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SORENSEN/A UNIT OF RAYTHEON CO., Richards Avenue, So. Norwalk, Conn.

14-3254B
3/63

WARRANTY

SORENSEN/A Unit of Raytheon Company, warrants each instrument it manufactures to be free from defects in material and workmanship. The company's obligation under this warranty is limited to servicing the instrument and replacing defective parts*, when the instrument is returned to the factory with transportation charges prepaid. This warranty is effective for one year after delivery of the instrument to the original purchaser. Defects caused by improper operating conditions, misuse, negligence, or the alteration or removal of the nameplate, will void the warranty. SORENSEN shall in no circumstance be liable for any direct or consequential loss or damage of any nature resulting from the malfunction of the instrument. This warranty is effective in lieu of any or all other obligations or liabilities on the part of SORENSEN/A Unit of Raytheon Company, its agents, or representatives.

SERVICE INFORMATION

Questions concerned with the operation, repair, or servicing of this instrument should be directed to the nearest Sorensen representative (a list is included with this manual) or to the Service Department, Sorensen/ A Unit of Raytheon Company, Richards Avenue, South Norwalk, Connecticut. Include the model number and serial number, in any correspondence concerning this instrument.

SHIPPING DAMAGE

It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be tested and inspected as soon as it is received. If the instrument shows signs of damage, follow the instructions on the DAMAGE and/or Loss in Shipment form enclosed with the unit and notify the carrier immediately. The carrier's claim agent will then prepare a report of damage and, after you have forwarded this to the Sorensen Service Department, you will be advised as to the action necessary to have the instrument repaired or replaced.

RETURNS TO THE FACTORY

Should it be necessary to return an instrument to the factory for repair, please contact the Sorensen Service Department for authorization to make shipment.
DO NOT RETURN THE UNIT FOR REPAIR WITHOUT THIS AUTHORIZATION.

* The warranty excludes special purpose tubes, which carry their own manufacturer's warrantees, and fuses.

II. SPECIFICATIONS

The Sorensen "Series 1000" Power Supplies are air and oil insulated power sources for laboratory or industrial application. They are ideally suited for use as breakdown testers, sources for cathode ray or power tubes, etc. A feature of these supplies is the ability to surge on the high voltage at any magnitude of power within their ratings.

MODEL		1001-500	1003-200	1006-10	1006-100	1012-50	1020-30	1030-20	1060-5
INPUT POWER	Voltage	117 VAC 60 Cps, Nominal							
	Current	8 Amps	8 Amps	3 Amps	8 Amps	8 Amps	8 Amps	8 Amps	6 Amps
OUTPUT POWER	Volts DC	0-1KV	0-3KV	0-6KV	0-6KV	0-12KV	0-20KV	0-30KV	0-60KV
	Current	500 ma	200 ma	10 ma	100 ma	50 ma	30 ma	20 ma	5 ma
% Regulation *		15	10	35	30	30	25	25	20
% Ripple *		3.0	1.5	0.4	1.5	1.0	2.0	3.0	1.75
SIZE (inches)	Width	19	19	19	19	19	19	19	19
	Height	21	21	8 3/4	21	21	21	21	21
	Depth	13	13	13	13	13	13	13	13
Weight (Net)		140 Lbs.	140 Lbs.	55 Lbs.	140 Lbs.	140 Lbs.	140 Lbs.	140 Lbs.	170 Lbs. **
Insulation		Air	Air	Air	Air	Air	Air	Air	Oil

* Regulation and ripple measured at nominal input.

** Includes oil.

SPECIFICATIONS CONT'D.

MODEL			1121	1151	1061					
INPUT POWER	Voltage		117 VAC Nominal Frequency 60 Cps.							
	Current		10 Amp	12 Amp	10 Amp					
OUTPUT POWER	Voltage		0-120KV	0-150KV	0-60KV					
	Current		5 MA	5 MA	10 MA					
INTERNAL IMPEDANCE			4 Meg	4.5 Meg	12 Meg					
RIPPLE (% RMS)			2.0	1.5	1.5					
CONTROL SECTION	Size (Inches)	W	22	22	19					
		H	12	12	8 3/4					
		D	15 1/4	15 1/4	15 1/4					
	Net (Lbs.)		50	55	50					
HIGH VOLTAGE SECTION	Size (Inches)	W	17	22 1/2	14					
		H	17	27	14					
		D	18 1/2	22 1/2	14					
	Net (Lbs.)		300*	700*	145*					
INSULATION			Oil	Oil	Oil					

* Including Oil

III. INSTALLATION AND OPERATION

The 1000 Series Power Supplies are applicable to any requirements where no more than 600 watts of very high voltage DC power is needed, such as nuclear physics, research, electrostatic painting and precipitation, cathode ray oscillography, etc. Attention has been given to safety without a sacrifice of any convenience in operation. Primary safety features include an overload relay and an automatic output voltage shorting solenoid.

DESIGN FEATURES

1. HIGH VOLTAGE CIRCUIT

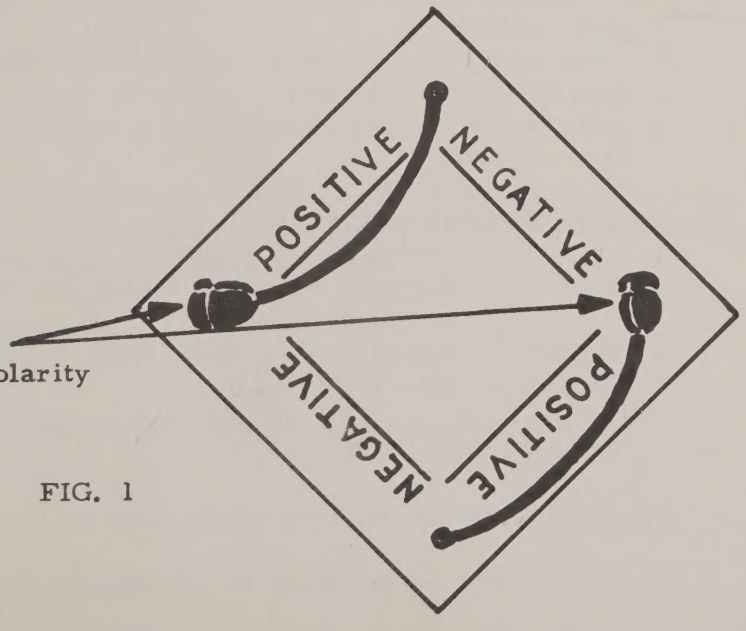
The various models employ either a full-wave doubler, a full-wave rectifier or a full-wave bridge.

The circuit for a particular supply is shown in the schematic diagram included with this manual.

2. POLARITY REVERSAL

Is effected by changing the positions of a set of plugs inside high voltage section. See Fig. 1. These plugs are accessible by removing the top and back covers.

Polarity reversal board shown for positive polarity. For negative polarity interchange the two plugs.
NOTE: For each polarity, wires follow along the appropriate words, engraved in the board.



Interchange these two plugs to reverse polarity

FIG. 1

3. OUTPUT VOLTAGE CONTROL

Is adjusted by means of a variable auto transformer (front panel control) which varies the AC input to the high voltage transformer rectifying circuit. The filaments (when tube rectifiers are used) are continuously energized by separate transformer.

4. METERING:

The output voltage and current are metered, with multiple ranges available in all designs, per Product Data Sheet. Special features of an electrical, metering, or control nature, are available as listed in the Product Data Sheet.

5. CONTROLS:*

1. High voltage off and overvoltage or overload reset pushbutton.
2. High voltage on pushbutton.
3. High voltage control variable auto transformer.
4. Meter polarity selector switch.
5. Main power toggle switch.
6. Fine high voltage control variable auto transformer.
7. Output current meter range selector switch.
8. Zero start interlock bypass pushbutton.
9. Overload trip control rheostat.
10. Output voltage meter range selector switch.
11. Overvoltage trip control rheostat.

6. PILOT LIGHTS: (All neon with frosted lens)

1. Main fuses open (2).
2. Overload.
3. High voltage on.
4. High voltage input transformer fuse blown.
5. External interlock open.
6. Main power.
7. Overvoltage.

7. POWER CONNECTIONS:

1.	Input	Standard recessed 3-pronged male receptacle, with 6 ft. line cord.
2.	Output:	RG 8/U cable, 8 ft. long.
3.	Ground:	Screw binding post.

8. AUXILIARY FEATURE:

Standard 3 pin convenience outlet, energized when the input is turned on.

* All controls are not provided on all models.

OPERATING INSTRUCTIONS

A. MECHANICAL

1. Open the carton or crate and check all panel surfaces for visible damage.

2. Remove the back cover from the cabinet.

   FOR OIL-FILLED high voltage section; lower the front panel, permitting removal of the tank from the chassis. Remove the screws atop the tank edge from their tapped holes and then raise the lid-suspended high voltage components from the tank.

3. Remove the tape that binds the output shorting mechanism's plunger, and any tape used to secure anti-corona nuts during shipment.

4. Insert all tubes that were shipped separately into their corresponding sockets, and connect plate caps.

5. Insert the polarity reversing plugs in proper jacks to correspond to high voltage positive or negative as desired. See Figure 1, Page 3.

NOTE: For OIL-FILLED units, fill the tank with clean, dehydrated transformer oil, * of at least 25kv test, Gulf Paramount #33 or equivalent, to the level indicated by the line stamped in the tank, about 2" from the top of tank. Next proceed as follows:

   a. Lower the high voltage components slowly into the oil, in order to minimize splashing and oil aeration. (Oil should be within 1/4 inch of top of tank).
   b. Refasten and replace tank in chassis.
   c. Connect the control section to the tank by means of the interconnecting cable.
   d. Reset front panel.

6. Remove the shorting wires from the meters.

7. Wire an external interlock, closed in the SAFE position, across pins of an ordinary 3-pin wall outlet plug that mates with the socket, on the chassis rear labelled FOR EXTERNAL INTERLOCK.

8. Replace the back cover.

* See Sorensen Service Bulletins #156 and #164, Pages 11, 12 & 13

B. ELECTRICAL

1. Ground the unit by means of the binding post provided on the rear of the chassis.

NOTE: ALWAYS OPERATE WITH A GOOD EXTERNAL GROUND.

BE CERTAIN THAT ALL PERSONNEL ARE PROPERLY PLACED WITH RESPECT TO THE HIGH VOLTAGE OUTPUT CABLE. THIS MEANS THAT NO ONE SHOULD BE WITHIN 1/2 FOOT OF THE OUTPUT END, UNLESS HE KNOWS EXACTLY WHAT HE IS DOING.

ALTHOUGH A LETHAL AMOUNT OF POWER MAY NOT BE AVAILABLE FROM THE POWER SUPPLY ITSELF, SECONDARY MECHANICAL EFFECTS DUE TO MECHANICAL MOVEMENT CAN BE DANGEROUS. IF A CAPACITOR IS BEING TESTED AT VOLTAGES SUCH THAT $1/2\ CE^2$ IS GREATER THAN 27, A LETHAL AMOUNT OF STORED ENERGY MAY BE AVAILABLE.

2. Connect output cable to load in such a position that it will not be in close proximity to ground. Keep away from all personnel.

NOTE: High voltage output cables for units below 30kv are terminated in alligator clips, while those for oil units are stripped back but remain unterminated.

3. Turn the HIGH VOLTAGE CONTROL to zero. Be sure that the MAIN POWER switch is in the OFF position.

4. Connect the power supply to a source of nominal 117 volts, 50/60 cycles, single phase, by means of the line cord provided.

5. Set the METER POLARITY selector switch to "+" or "-", corresponding to the setting of plugs and jacks in the high voltage section.

6. Set OUTPUT VOLTAGE AND OUTPUT CURRENT METER range selector switch to the range desired.

7. Set the MAIN POWER switch to ON.

8a. Set the OVERLOAD TRIP CONTROL to the desired trip current. Refer to drawings for the calibration of trip current vs. overload trip control setting, supplied with this manual.

8b. Set the OVERVOLTAGE TRIP CONTROL (if used) to the desired trip voltage. Refer to drawings for the calibration of trip voltage vs. overvoltage trip control setting, supplied with this manual.

9. Set the HIGH VOLTAGE CONTROL to zero. (Recommended, but not mandatory).

   Depress the HIGH VOLTAGE ON pushbutton.

   For high voltage surge-on, simultaneously depress the ZERO START BY-PASS pushbutton. (Used when High Voltage Control is off zero).

10. Turn the HIGH VOLTAGE CONTROL clockwise until the rated output voltage and/or current is indicated.

11. TURN OFF:

    a. Turn the HIGH VOLTAGE CONTROL to zero (advisable, not mandatory).
    b. Depress the HIGH VOLTAGE OFF pushbutton.
    c. Set the MAIN POWER switch to OFF.
    d. In case of emergency, there should be no hesitation to depress the HIGH VOLTAGE OFF pushbutton at once.

12. TO RESET AFTER AN OVERLOAD

    a. Remedy the condition that caused the overload.
    b. Turn the HIGH VOLTAGE CONTROL to zero.
    c. Depress the OVERVOLTAGE OR OVERLOAD RESET pushbutton.
    d. Repeat steps 8 through 10 above.

13. TO RESET AFTER AN OVERVOLTAGE

    a. Remedy the condition that caused the overvoltage.
    b. Repeat steps 12b, c and d.

X-RAY PRECAUTION NOTICE

It is well known that all voltage generating equipment using tube-type rectifiers to derive voltages in excess of 20 kilovolts, are subject to X-Ray emanation. Therefore, certain precautions must be observed in operating such high voltage supplies.

The specific operating precaution, applicable to your supply, is stencilled on your equipment. If this precaution is observed, safety of personnel is assured. The stated proximity limits are derived from the safe dosage level established by the National Committee on Radiation Protection, as presented in the Addendum to National Bureau of Standards Handbook 59, entitled "Permissible Dose from External Sources of Ionizing Radiation."

If however, the stencilled precaution cannot be fully observed, then we recommend the following additional safety precautions:

1. Monitor all personnel, either with dosimeters or film badge methods, per information contained in National Bureau of Standards Handbooks:

   #51 entitled "Radiological Monitoring Method & Instruments".
   #59 entitled "Permissible Dose from External Sources of Ionizing Radiation."
   #76 entitled "Medical X-ray Protection to 3 Million Volts"

2. Add additional shielding in those areas required. Information for this may be obtained from NBS Handbook #50 entitled "X-ray Protection Design".

Any additional data you may require can be obtained from the Factory Service Department.

February 20, 1959 Bulletin No. 156

TRANSFORMER INSULATING OIL-HIGH VOLTAGE SUPPLIES

PURPOSE: To advise representatives and customers of the correct type of transformer insulating oil to use in our high voltage power supplies.

OUTLINE: We have had several incidents where the use of "Pyranol" (Monsanto type "Aroclors") as an insulating oil in our high voltage supplies has resulted in the complete destruction of the high voltage section.

Chlorinated dielectric oils are highly destructive to the lucite insulation and barriers used in the high voltage section, and their use will cause the section to disintegrate within a matter of days after use.

The serious nature of this problem has made it mandatory for us to take immediate action to insure that further problems and use of chlorine based oils are a thing of the past.

UNITS AFFECTED: All Oil Insulated Power Supplies previously manufactured by Beta Electric and currently manufactured by Sorensen.

DESTRUCTIVE OILS: Following is a list of the chlorine based oils which are destructive in our supplies, and under no circumstances should they be used: They are listed by "trade" names:

Name	Manufacturer
Chlorextol	Allis-Chalmers
Diaclor	Sangamo Electric
Dykanol	Cornell Dubilier
Elemex	Line Materials
Hyvol	Aerovox
Inerteen	Westinghouse
Noflamol	Wagner Electric
Pyranol	General Electric

This list cannot be assumed as complete. We have no control as to other similar oils contemplated or not in wide distribution. If a doubt arises, please consult us.

WHAT OIL TO USE: Following is a list of some important characteristics that the transformer oil should have in order to be used in our High Voltage Sections.

1. A high dielectric strength of at least 25KV test.
2. Low viscosity and density to aid in dissipating an arc due to flashover as well as for transferring heat.
3. Freedom from inorganic chlorides, sulfates, alkalis, and corrosive sulfur to prevent any damage to the insulating materials or conductors.
4. Good resistance to emulsion so that any moisture will, upon entering the oil, be held down instead of being suspended.
5. A relatively high flash and fire point.

Based upon the following requirements, the following mineral base transformer oils are recommended:

Manufacturer	Type
* Gulf	Paramount #33
* Shell	Dialaax
* Esso	Univolt #35
Tydol	Avon
Texaco	#55

* These oils are used by our Service Department and High Voltage Laboratory.

CORRECTIVE ACTION: We are taking action within Sorensen to insure that all instruction manuals and high voltage tanks on future shipments have the following statement inserted and screened on the tank:

IMPORTANT

USE ONLY MINERAL BASE TRANSFORMER OILS IN THIS POWER SUPPLY. THE FOLLOWING TYPES ARE RECOMMENDED:

GULF, Paramount #33
SHELL, Dialaax
ESSO, Univolt #35
TYDOL, Avon
TEXACO, #55

We are asking our representatives to inform all customers by means of this bulletin, that prior to the purchase of a new supply (or to the addition of new oil to an older supply) that they make arrangements to obtain the proper mineral based oil.

March 9, 1961 Bulletin # 164

PREPARING HV OIL

Purpose: To provide field personnel with information on preparing the transformer insulating oil in the tanks of high voltage power supplies.

Units affected: All units of 50KV output or higher.

Outline: For proper functioning of this equipment it is necessary to use a good grade of "non-additive" transformer oil* and to make certain that all air is expelled from the oil before the unit is brought up to full voltage. In order to accomplish this, it is desirable to take the necessary time and care required to bring the power supply up to operating condition.

Caution: The following steps should be followed (only up to the specified rating of the power supply being prepared):

1. Turn on filament power for one hour (high voltage off).

2. Raise DC voltage to 33% of rated output voltage, no load on the output. Note the leakage current. Unit must be aged at this voltage until leakage current is less than 10 micro amps and for a minimum of two hours. (preferably for four hours).

Look through the port holes for a collection of large air pockets in the oil or on the surface of the oil. These air pockets must be removed before proceeding. This can sometimes be done by simply jarring the tank. If this does not remove them, it may be necessary to untank the unit and start over.

3. Repeat step 2 at 50% of rated output voltage.

4. Repeat step 2 at 75% of rated output voltage.

5. Repeat step 2 at 100% rated output voltage.

The unit is ready to operate after reaching and completing step 2 at the rated output voltage of the power supply.

Note: The above procedure must be followed whenever the oil is changed or refiltered.

* See Sorensen Service Bulletin #156 "Transformer Insulating Oil - High Voltage Supplies".

Waldo Prescod
3/10/62

WP/bmw

IV. PRINCIPLE OF OPERATION

All of the circuits and functions of the power supply are quite straightforward and can be readily understood by referring to the schematic circuit diagram.

The input power is applied, through various switches and contacts (to be discussed later), to the variable auto transformer T1. T1 is adjusted by coarse control (front panel) to vary, from 0-135 volts, the AC input voltage to the high voltage transformer T2.

The output of T2 is rectified and doubled by means of rectifiers and capacitors in a conventional full wave doubler circuit. (See Fig. 2). A brief description of this type of circuit is given below.

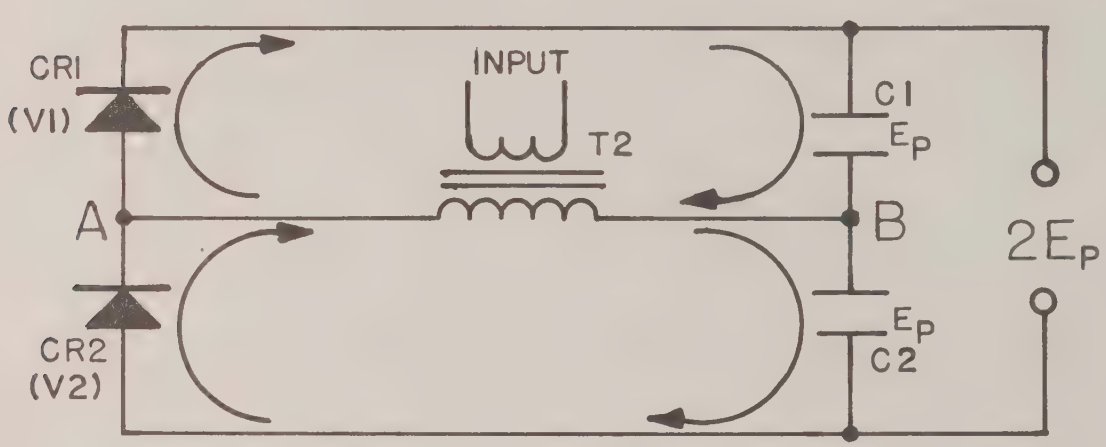


FIG. 2

When the polarity of Point A is negative with respect to point B, rectifier CR2 (V2) will conduct with a current in the direction indicated, and capacitor C2 will charge to the potential Ep. The potential Ep will equal the crest voltage of the secondary of the transformer T2. (For example: if the secondary voltage were 40KV RMS, the peak voltage would be 40KV times 1.414 or 56KV peak). In the next half of the cycle, of the applied 60 cycle wave, point A will become positive with respect to point B and rectifier CR1 (V1) will conduct in the direction shown. Capacitor C1 will charge to the voltage Ep. It is now apparent that the potential appearing across C2 and C1 will be equal to twice Ep.

It is in this manner that the doubling is accomplished. It should be noted that the trans formers, rectifiers, and capacitors were treated as lossless. The effect of load resistance was also neglected. These things would introduce losses and would require a higher secondary voltage on the transformer to overcome them. However, for our ease of understanding, doubling is theoretically perfect.

The output of T2 may also be fed into a conventional full wave rectifier. (See Figure 3). or a full wave bridge (See Fig. 4).

Single Phase Full Wave Rectifiers

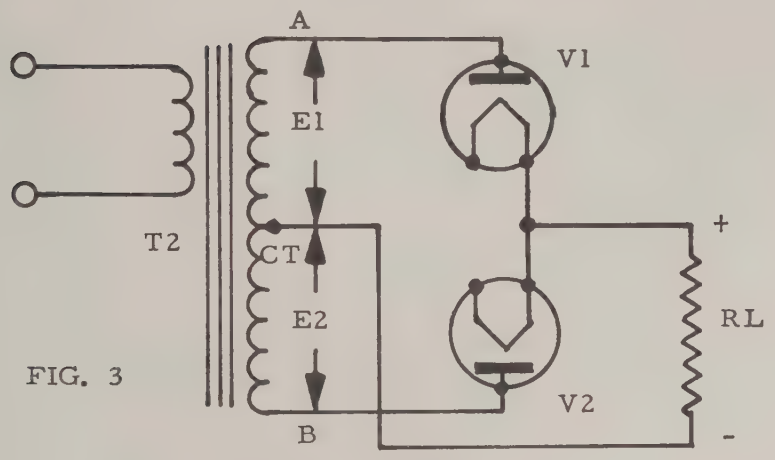


FIG. 3

The output voltage of T2 is applied to the plates of Rectifiers V1 and V2. During the half cycle in which the polarity of point A is positive with respect to point CT, V1 conducts to the load RL. V2 is nonconducting during this period. During the next half cycle, the voltage reverses. V1 shuts off and V2 conducts. The current flows to the load, RL through V2 in the same direction as on the first half cycle. The DC output voltage across RL is approximately given by:

$$EDC = \frac{E1}{1.11}$$

$$1.11\ EDC = E1 = E2$$

Where EDC is the DC potential across RL, and E1 and E2 are RMS AC Voltages

For example: In Model 1001-500

EDC = 1 KV

Therefore: 2.22KV RMS (E1 + E2) is needed on the secondary of T2.

Full Wave Bridge Circuit

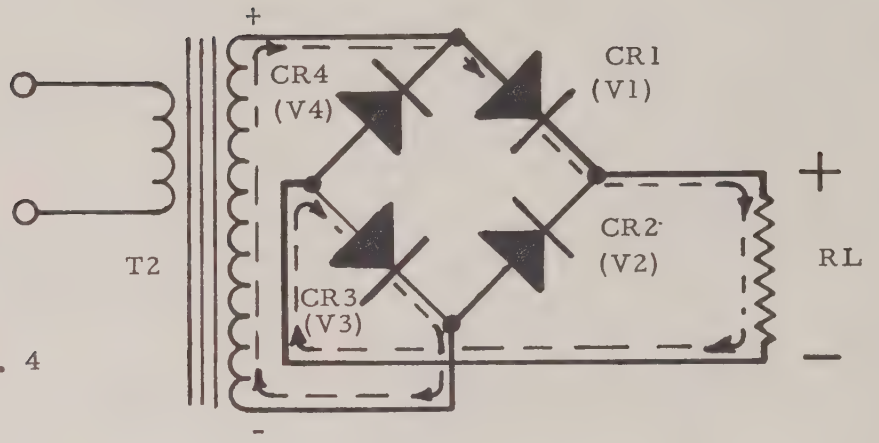


FIG. 4

During the first half cycle, suppose the polarity of T2 is as indicated in Fig. 4 CR1 (V1) and CR3 (V3) are conducting and current flows from the positive to the negative end of the load RL. The conduction path is shown by the dotted line.

During the next half cycle the transformer voltage reverses its polarity, and CR1 (V1), CR3 (V3) remain nonconducting, while CR2 (V2) and CR4 (V4) send current through the load in the same direction as that during the previous half cycle.

The output DC voltage = $\frac{\text{Erms}}{1.1}$

For example: Edc = 1000V

Then the secondary voltage Erms = 1000 X 1.1
= 1100V

1. BLOWN FUSE AND OPEN SWITCH INDICATORS:

Neon glow lamps, such as I1, shine when the parallel fuse is blown or paralleled switch is open, thus indicating immediately the cause of in-operation of the power supply. The lamp holders have built-in resistors, limiting the lamp current to approximately 1 milliampere, so that none of the circuit BEYOND THE LAMP will be operated by the small current that flows through the lamp.

2. NEON PILOT LIGHT CURRENT RETURN RESISTORS:

Resistors such as R1 ensure illumination of the adjacent neon glow lamp in case of blown fuse or open switch paralleled by the indicator and an open circuit beyond the resistor.

3. HOLDING RELAY FOR OVERLOAD PROTECTION:

Relay K1 pulls in when contacts 3a of the overload relay K3 close momentaril When K1 is energized, contacts 1b open, de-energizying the high voltage circuits. Contacts 1a close and maintain K1 energized, even though contacts 3a have now opened due to contacts 1b having opened, removing primary power from the high voltage circuit. Depressing S1, HIGH VOLTAGE OFF & OVER VOLTAGE-OVERLOAD RESET, de-energizes K1 and resets the system for operation after the overload.

Pilot Light I4, OVERLOAD, is illuminated for the overload condition.

4. HOLDING RELAY FOR OVERVOLTAGE PROTECTION:

Relay K7 pulls in when contacts 6a of the overvoltage relay (K6) close momentarily. When K7 is energized, contacts 7b open, de-energizing the high voltage circuits. Contacts 7a close and maintain K7 energized, even though contacts 6a have now opened due to contacts 7b having opened, removing primary power from the high voltage circuit. Depressing S1, HIGH VOLTAGE OFF, OVERVOLTAGE-OVERLOAD RESET, de-energizes K7 and resets the system for operation after the overvoltage.

5. HIGH VOLTAGE "HOLDING"

K2 contacts are normally closed shorting output to ground through R5. When the HIGH VOLTAGE ON pushbutton S2 is depressed, solenoid K2 is energized, removing the short from the output, through resistor R5. At the same time, K4 is energized, closing contact 4c, thus bypassing S2 and allowing S2 to be released, maintaining high voltage.

6. HIGH VOLTAGE GENERATING CIRCUITS:

The high voltage is controlled by the output of variable auto transformer T1 (coarse High Voltage Control). This control varies the AC input to the high voltage transformer T2 from 0 to 135 volts.

The output of T2 is rectified by means of rectifiers and filters in a circuit that is most appropriate for the particular application. The circuits employed are:

a. Full-wave doubler (most common)
b. Full-wave rectifier (for high current)
c. Full-wave bridge

7. POLARITY REVERSAL:

The high voltage is made positive or negative with respect to ground by means of reversing the polarity of the rectifiers. This reversal is accomplished by means of plugs and jacks located in the high voltage section. See Figure 1, Page 3.

8. METERING AND OVERLOAD CIRCUITS:

The output voltage metering circuit consists of resistors R4 and R6 and the range calibrating potentiometers R11, R12 and R13 and Meter M1. R11, R12 and R13 are located at the top front of the control section. They are directly beneath the top cover of the unit.

It is to be noted that the return of the output voltage metering circuit is not to ground, but to the "high" end of the OUTPUT CURRENT metering circuit M2. Thus, the output current meter does not indicate the current drawn by the kilovoltmeter circuit.

R14, R15 and R16 are potentiometers used to calibrate the current meter (M2) ranges. These potentiometers are located at the bottom center of the control section.

In series with the OUTPUT CURRENT meter M2 is the overload relay K3. This relay is calibrated to ensure pull in at the rated currents.

Capacitor C5 allows the relay K3 to pull in on average current, rather than the large peak currents that flow through the rectifier circuit.

In series with the OUTPUT VOLTAGE Meter M1 is the over voltage relay K6. This relay turns off the primary power, if the over-voltage exceeds approximately 10% to 115% of rated voltage, thus protecting load circuits. The trip voltage is varied by means of a control panel adjustment.

V. MAINTENANCE AND REPAIR

I. CAUTION

When trouble shooting, be certain that all personnel are properly placed with respect to the output cable. There are dangerous high voltages present in this supply and it should be serviced only by informed and skilled personnel.

II. POWER SUPPLY TROUBLE vs. APPLICATION

A. The first thing to determine is whether the difficulty is with the power supply or with the application.

This can be determined by making the following tests:

1. LOAD DISCONNECT:
   Disconnect output cable from load. Hang output cable in air away from ground and all personnel.

2. NO LOAD TEST:
   Turn overload control to minimum. Raise H. V. CONTROL on front panel until kilovoltmeter reads rated maximum output voltage. (Leave on for approximately 15 minutes). If trouble does not develop, then:
   a. Turn HIGH VOLTAGE CONTROL to zero.
   b. Turn unit off.

3. SHORT CIRCUIT TESTS:
   Connect output cable tip (H. V. end) to ground. Turn overload trip control on front panel fully clockwise. Raise coarse HIGH VOLTAGE CONTROL on front panel very slowly until rated output current is read. (Leave on for approximately 15 minutes). A small rotation of the coarse HIGH VOLTAGE CONTROL should give full current. Turn unit off.

B. If the above tests show normal power supply operation, the trouble is most likely in your load application. We suggest you contact our representative in your area for assistance.

C. <u>If power supply operation is not normal,</u> then proceed as follows:

(1) If the NO LOAD TEST is satisfactory, and the SHORT CIRCUIT TEST is not, refer to Trouble Shooting Section.

(2) If the SHORT CIRCUIT TEST is satisfactory, and the NO LOAD TEST is not, refer to Trouble Shooting Section.

(3) If flashing or arc-over occurs in the High Voltage Section before rated output voltage is obtained in the NO LOAD TEST, refer to Trouble Shooting Section.

(4) If no output voltage or current is obtained in the NO LOAD TEST and the SHORT CIRCUIT TEST, refer to Trouble Shooting Sections III to VI.

III. FLASHING IN HIGH VOLTAGE SECTION:

NOTE: Overload or overvoltage relay may trip after flashover. This can be determined by Pilot light on front panel.

PROBABLE CAUSE	REMEDIAL ACTION
IMPROPER LOAD	
Load may be open or arcing to ground.	Remove load and check unit at no load.
OIL AERATION:*	
This usually occurs when High Voltage Section is untanked frequently. Entrapped air will cause some loss of insulation properties of oil.	Before raising output voltage, allow frame to set in oil approximately 1/2 hour to remove major air pockets. Operate at 3/4 voltage to help drive out excess air.
INSUFFICIENT OIL:*	
Oil level must be approximately 1/4" from top of tank cover.	Fill oil to approximately 1/4" from top of tank cover with the frame in place.
CONTAMINATED OIL:*	
This will lower the dielectric strength of the oil.	Filter or replace oil.
BROKEN LEAD (S):	
Leads may be disconnected and cause arcing.	Inspect High Voltage Section for broken leads on transformers, tubes, capacitors, rectifiers, etc.
FOREIGN MATTER IN HIGH VOLTAGE SECTION	
Objects such as screws, nuts, bits of metal floating above ground potential may cause arcing.	Inspect for foreign matter such as nuts, screws, pieces of wires, etc. wedged in frame or cabinet. Remove.
Output cable not seated properly.	Check to see that cable plug mates properly with jack.

If the cause of flashing is not eliminated by any of the above remedial actions, it will be necessary to remove the frame from the tank and raise the output voltage to 1/3 rated output voltage in air. DO NOT RAISE ABOVE 1/3 RATED VOLTAGE IN AIR. Watch for signs of corona and/or arcing as they usually indicate source of trouble. There is dangerous High Voltage present and extreme caution should be observed.

* Oil insulated units only.

IV. NO OUTPUT CURRENT (Output Voltage O. K.)

Meter range switch in "Transit" position	Remove short
No ground connection	Connect a common ground to load and all metal housings. (Tanks and cabinets).
Calibrating potentiometer in meter circuit shorted.	Check potentiometer for short with ohmeter. Isolate circuit as required.
Defective Meter	Check power supply meter against standard meter.
Open load	Check Load.

If the above does not succeed in locating the difficulty, remove the load and place a milliammeter between output and ground. Observe proper polarity. If current is read, the trouble is probably in the milliammeter circuit in the control section.

Notify our representative in your area for assistance if the above does not remedy your difficulty.

V. NO OUTPUT VOLTAGE (Output Current O. K.)

Meter range in "Transit" position	Remove short
Calibrating potentiometers(across meters)shorted.	Check potentiometer for short with ohmeter. Isolate circuit as required.
Defective meter	Check power supply meter against standard meter.
Load shorted	Check load.

If the above does not succeed in locating the difficulty, remove load and place a kilovoltmeter from output to ground. Raise HIGH VOLTAGE CONTROL until meter reads. (The voltage read is limited by the capability of the external meter). If voltage is being generated, the trouble is probably in the kilovoltmeter circuit. Notify our representative in your area for assistance if the above does not remedy your difficulty, or contact the Service Department, Sorensen/A Unit of Raytheon Co., Richards Ave., South Norwalk, Connecticut.

VI. NO OUTPUT VOLTAGE OR CURRENT

Meter shorted by transit position	Remove short.

No output from variable auto transformer	Check variable auto transformer brushes and input voltage.
Tubes (if any) not in socket or defective	Check for proper seating of tube in socket. Filaments should be lit. If not, check tubes and/or filament transformer (s).
Polarity reversal plugs, improperly connected or not connected.	Check for proper seating of reversing plugs.
High voltage transformer defective.	Check to see if any output voltage is obtained by placing an AC kilovoltmeter from the high end of transformer to ground.
High voltage transformer input fuse blown.	Replace fuse. NOTE: The indicating lamp on the front panel will not light unless the HIGH VOLTAGE CONTROL is brought up to about 60 on the dial.

If any of the above does not remedy the difficulty, please call our representative in your area, or contact the Service Department, Sorensen/A Unit of Raytheon, Richards Avenue, South Norwalk, Connecticut.

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